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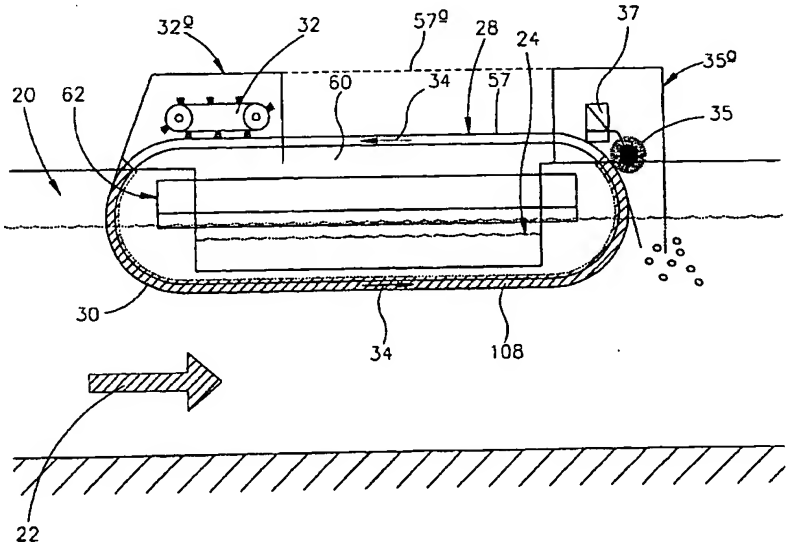
(54) Title: SCREENING APPARATUS FOR USE IN A SEWERAGE SYSTEM AND METHOD OF SCREENING AN EXCESS FLOW IN A SEWERAGE SYSTEM



(57) Abstract: Apparatus for use in a sewerage system having a channel (20) for sewage flow (22), the channel (20) having an overflow weir (24) over which an excess flow is discharged when the flow in the channel (20) exceeds a predetermined level, in use, the apparatus comprising a screen arrangement (28) arranged along the overflow weir (24) such that the excess flow passes through the screen arrangement (28) prior to discharge over the overflow weir (24). The screen arrangement (28) comprises a continuous belt screen (30) for capturing screenings contained within the excess flow so as to substantially prevent the discharge of screenings over the overflow weir (24). The invention also relates to a method of screening an overflow in a sewerage system.

WO 01/30481 A1

SCREENING APPARATUS FOR USE IN A SEWERAGE SYSTEM AND METHOD OF SCREENING AN EXCESS FLOW IN A SEWERAGE SYSTEM

The invention relates to an apparatus for use in screening an excess flow in a sewerage system. The invention also relates to a method of screening an excess flow in a sewerage system.

The flow in sewerage systems is carried through channels to the screening and processing stages of a downstream sewage treatment installation or pump station. In older sewerage systems, the input sewage flow can include rain or storm water such that, during periods in which there is relatively high rainfall, the level of the flow carried through the channels increases. To cope with such increased flow rates, the channels are commonly provided with overflow weirs which permit excess rain water carried through the channels to be discharged from the channels, prior to the flow reaching the downstream stages of the sewerage system.

Figure 1 is a perspective view of a channel 10 in a sewerage system through which a sewage flow 11 is carried to a downstream pump station or sewage treatment installation, the channel 10 being provided with an overflow weir 12 for discharging excess rain water through an outlet channel 14. The outlet channel 14 usually carries excess rain water discharged over the weir 12 into a receiving water course, such as a river or the sea, or a storm water collecting tank.

A problem exists in conventional arrangements, such as that shown in Figure 1, in that the excess flow discharged over the overflow weir 12 inevitably carries

solid materials, such as rags, papers, polythene and other plastic materials, commonly referred to as screenings, which are carried by the input sewage flow. These products are often contaminated by organic products and pose a dangerous health hazard if they are discharged into the receiving water course. It is therefore desirable to screen the excess flow before it is discharged over the weir. However, in many existing sewerage systems, the channels and the overflow weirs are located under the ground and only a limited space is available for accommodating any form of screening apparatus. It is not therefore possible to arrange conventional screen arrangements within the channels in order to screen the inlet flow, as there is insufficient installation space.

It is known to provide elongate slot screens along the edge of the weir to try to prevent contaminated products present in the excess flow from being discharged over the weir and through the outlet channel to the receiving water course. Such screens can take the form of a series of horizontal slots or apertures, although screens of this type suffer from the disadvantage that they only present a barrier to solid materials in the excess flow in one dimension and therefore only provide a limited screening function. It is also known to provide elongate perforated screens along the edge of the weir to screen the excess flow, the screens being either of planar or curved form. Although such screens provide an improved screening function, it is difficult to clean screens of this type. Furthermore, such screens have a relatively large head loss, placing an often undesirable limit on the maximum allowable excess flow level the sewerage system can be operated at.

It is an object of the present invention to provide an apparatus for use in a sewerage system which overcomes the aforementioned disadvantages.

According to the present invention, there is provided an apparatus for use in a sewerage system having a channel for a sewage flow, the channel having an overflow weir over which an excess flow is discharged when the flow in the channel exceeds a predetermined level, in use, the apparatus comprising a screen arrangement arranged along the overflow weir such that the excess flow passes through the screen arrangement prior to discharge over the overflow weir, the screen arrangement comprising a continuous belt screen for capturing screenings contained within the excess flow to enable their subsequent removal therefrom.

The invention provides the advantage that the screen arrangement prevents solid materials, such as rags, papers, polythene and other plastic materials, in the excess flow from being discharged over the overflow weir. Such screenings may be contaminated by organic products carried by the sewage flow and would otherwise be discharged over the overflow weir into an outlet channel for delivery to a receiving water course or storm water collecting tank, thereby giving rise to a dangerous health hazard. As the discharge of screenings over the overflow weir is prevented, and as the screenings are returned to the main sewage flow through the channel, the screenings can be subsequently removed from the flow downstream of the overflow weir by appropriate means for safe disposal.

The screening apparatus of the present invention enables such screenings to be retained within the flow in the channel for onward passage to the downstream parts of the sewerage system. As the screen arrangement is arranged along the overflow weir and is suspended above the channel, there is sufficient room to accommodate the screen arrangement in existing sewerage systems which are often located under the ground. The continuous belt screen also presents a

relatively large screening area to the excess flow and has a lower head loss than conventional types of storm water screening apparatus.

The screen arrangement may further comprise a front plate which is provided with an overflow aperture.

Thus, in the event of excessive rainfall, for example during extreme storm conditions when the excess flow level exceeds the expected maximum level, some of the unpredicted excess flow is able to by-pass the continuous belt screen and flow directly to the outlet channel to substantially prevent flooding of the screen arrangement.

Preferably, the screen arrangement is provided with an outer cover member for the overflow aperture.

The provision of the outer cover member for the overflow aperture enables higher sewage levels through the flow channel before excess flow flows through the overflow aperture. As the permitted level of flow through the channel is increased, the permitted head loss of the screen arrangement is increased. The flow capacity of the screen arrangement is therefore also increased.

The screen arrangement is preferably provided with a sealing arrangement which serves to prevent the passage of flow into the screen arrangement in normal storm conditions, other than the flow screened by the continuous belt screen.

For the purpose of this specification, normal storm conditions shall be taken to mean conditions in which the excess flow passing through the screen arrangement does not exceed the level at which there is flow through the overflow aperture.

Preferably, the sealing arrangement includes a sealing shroud or cover member which extends partially around the continuous belt screen so as to ensure the sewage flow in the channel is substantially sealed from the downstream side of the screen arrangement, other than through the screen panels forming part of the continuous belt screen. The continuous belt screen has a front facing side and an opposed rear facing side and the sealing shroud member is preferably provided on both the front and rear facing sides.

The apparatus may comprise a drive mechanism, the drive mechanism being located externally to the belt screen. In conventional screen arrangements, it is usual to mount the drive mechanism internally within the screen arrangement. Such arrangements are not therefore suitable for use in the present invention as the drive mechanism would be exposed to the excess flow which is passed over the weir.

In use, the direction of travel of the continuous belt screen exposed to the excess flow is preferably along the direction of flow of the sewage flow.

The screen arrangement has a longitudinal axis, the longitudinal axis conveniently being arranged substantially parallel to the overflow weir. As the longitudinal axis of the screen arrangement is in a substantially horizontal direction, a reduced space is required to accommodate the screen arrangement.

The apparatus may include more than one screen arrangement arranged along the overflow weir. The or each screen arrangement may be suspended over the channel and may span the channel.

The invention also relates to a method of screening an overflow in a sewerage system having a channel provided with an overflow weir, comprising the steps of;

arranging a screen arrangement having a continuous belt screen along the overflow weir, and

driving the belt screen by means of a drive mechanism so as to present a substantially continuous screening area to the excess flow so as to substantially prevent the discharge of screenings over the overflow weir.

The method may include the further step of providing means for switching the drive mechanism between on and off states, in response to a measured flow level within the channel.

For the purpose of this specification, the phrase "screenings" is intended to mean the solid materials, including rags, papers, polythene and other plastic materials, which are removed from the excess flow by the screening arrangement.

The invention will now be described, by way of example only, with reference to the accompanying drawings in which:-

Figure 1 is a perspective view of a channel in a conventional sewerage system;

Figure 2 is a side view of an embodiment of the apparatus of the present invention;

Figure 3 is a plan view of the apparatus in Figure 2;

Figure 4 is a perspective view of the apparatus in Figures 2 and 3;

Figure 5 is a perspective view of a screen arrangement forming part of the apparatus in Figures 2-4;

Figure 6 is an enlarged perspective view of a part of the screen arrangement in Figure 5;

Figure 7 is a schematic side view of a part of the apparatus in Figures 2 to 4 to illustrate the effects of providing an overflow aperture in the screen arrangement;

Figure 8 is an end view of the apparatus in Figures 2 to 4 to illustrate the sealing arrangement which may form part of the apparatus;

Figure 9 is a schematic side view of the screen arrangement in Figure 5 to illustrate the drive mechanism; and

Figure 10 is an enlarged view of a part of the screen arrangement in Figures 5, 6 and 9 to further illustrate the drive mechanism.

Referring to Figures 2 to 4, a channel 20 forming part of a sewerage system carries a sewage flow, as indicated by arrow 22, to the downstream stages of the sewerage system, such as a sewage treatment installation or pump station. The channel 20 is provided with an overflow weir 24 over which excess rain or storm water flowing through the channel 20 with the sewage flow 22 is discharged, as indicated by arrows 26 in Figure 3. The overflow weir 24 is on the rear facing side of the screen arrangement 28 in the illustration shown in Figure 2. In circumstances in which there is relatively low rainfall, the level of flow in the channel 20 is sufficiently low that no excess flow is discharged over the overflow weir 24. However, in circumstances in which there is a relatively high rainfall, such as in storm conditions, the level of flow in the channel 20 increases such that excess rain water delivered to the channel 20 is discharged over the overflow weir 24 prior to the sewage flow 22 reaching the downstream stages of the sewerage system.

A screen arrangement 28 is arranged along the overflow weir 24, the screen arrangement 28 comprising a continuous belt screen 30, as indicated by the dotted line in Figure 2, which is driven by means of a drive mechanism 32 arranged within a first housing 32a, such that a substantially continuous moving screening area is presented to the excess flow prior to its passage over the weir 24. As can be seen most clearly in Figure 4, the screen arrangement 28 is therefore suspended over at least a part of the channel 20 to present a screening area to flow in the channel which exceeds a predetermined level. In use, the continuous belt screen 30 is driven in a direction substantially parallel to the direction of the input flow 22, as indicated by arrow 34 in Figure 2.

Referring to Figure 5, the screen arrangement 28 includes a number of screen panels 38, each panel 38 being formed from a perforated metal sheet

comprising a plurality of perforations 31. The screen panels 38 are connected so as to form a continuous loop which forms the belt screen 30, each screen panel 38 being connected to the adjacent screen panels, one on each side, by means of hinging pins 40. Referring to Figure 6, a link member 42 is mounted at each end of the screen panels 38. The hinge pins 40 pass through a plurality of interdigitated lugs (not shown) arranged along the edge of each screen panel 38. The hinge pins 40 also pass through apertures formed in the link members 42, thereby securing the link members 42 to their respective screen panel 38. Each of the link members 42 also includes a drive pin 44, or peg, projecting laterally therefrom. It will be appreciated that the screen panels need not be formed from metal, but may be formed from another kind of material, such as plastic.

The perforations 31 provided in the screen panels 38 enable excess flow in the liquid phase to pass through the panels 38 to the inside of the screen arrangement 28, from where the excess flow passes over the overflow weir 24 into an outlet channel (not shown) for delivery to a receiving water course. However, the perforations 31 are dimensioned such that solid materials in the excess flow, having a greater dimension than the perforations 31, are prevented from passing therethrough. The screened solids are held against the screen panels 38 and travel with the belt screen 30 as it is driven in the direction of travel to the end of the screen arrangement 28 (the right hand end as shown in Figures 2 and 3). As the belt screen 30 moves out of the flow at the end of the screen arrangement 28, some of the screenings will fall from the belt screen 30 and return to the flow where they travel to the downstream parts of the sewerage system. Others of the screenings adhere to the screen panels 38 as the belt screen 30 travels out of the flow where they are removed from the belt screen 30 by means of a rotary brush 35 mounted externally to the screen

arrangement 28 within a second housing 35a as they are conveyed therepast. These screenings are also discharged back into the inlet sewage flow 22, downstream of the overflow weir 24, and are therefore conveyed to the downstream screening stages of the sewerage system..

Preferably, in addition to the rotary brush 35, a washing liquid such as water may be used to aid cleaning of the belt screen 30. Such liquid may be supplied by a pump arranged to draw liquid from the outlet channel on the "clean" side of the overflow weir 24 and to supply the liquid to a deluge tray 37 arranged above the rotary brush 35.

As shown in Figure 2, a sealing shroud or cover 108 extends around the belt screen 30, on both the front and rear facing sides of the screen arrangement 28, to ensure a substantially fluid tight seal is provided between the screen arrangement housing and the screen panels 38, as will be described in further detail hereinafter.

The screen arrangement includes a front plate 60 which presents a barrier to the flow in the channel 20 to ensure that, under normal circumstances, none of the excess flow is discharged over the overflow weir 24 without passing through the belt screen 30. Preferably, a closure plate or cover 57 is provided on the uppermost side of the screen arrangement between the first and second housings 32a, 35a.

The front plate 60 is preferably provided with an overflow aperture 62, on the front facing side of the screen arrangement 28 (in the illustration shown in Figure 2), the overflow aperture 62 being arranged above the operating flow level of the channel 20 in normal storm conditions. In conditions when there is

an extreme quantity of rainfall and the level of flow in the channel 20 increases above the normal operating level to give an unpredicted excess flow, the excess flow is able to pass through the overflow aperture 62 and by-pass the belt screen 30. This prevents the screen arrangement 28 from becoming flooded and is particularly advantageous in that it prevents the drive mechanism 32, arranged on top of the screen arrangement, from being contaminated by the excess flow. In particular, this is beneficial in the event of a power failure, which can be a common occurrence in storm conditions, as the aperture 62 permits excess flow to pass over the overflow weir 24 even if the power supply to the drive mechanism 32 fails.

Depending on the circumstances in which the screen arrangement is to be used, for example the likely sewage flow levels in the channel 20 and the required sewage flow capacity of the screen arrangement, it may be desirable to provide an outer cover member 61 (as shown in Figure 4) for the overflow aperture 62. One problem with providing the overflow aperture 62 is that the permitted head loss (i.e. the difference in flow level between the sewage flow level upstream of the screen arrangement and the sewage flow level downstream of the screen arrangement) is restricted, and this restricts the sewage flow capacity of the screen arrangement. In order to overcome this problem, and to ensure the screen arrangement retains a large sewage flow capacity even with the provision of the overflow aperture 62, the outer cover member 61 is mounted on the screen arrangement 28 so as to partially enclose the overflow aperture 62 from sewage flow in the main sewage flow channel 20.

The advantage of providing the outer cover member 61 for the overflow aperture 62 is described with reference to Figure 7 which shows three possible sewage levels in the channel 20. Level A represents the level of flow under

normal storm conditions, Level B represents the level of flow when there is a higher than usual amount of rainfall in storm conditions and Level C represents the level of flow in extreme storm conditions (e.g. when there is an excessive rainfall in storm conditions). Level D represents the downstream level of sewage flow i.e. after the flow has passed through the screen arrangement 28.

It can be seen that, if no outer cover member 61 is provided for the overflow aperture 62, the permitted level (Level A) of flow in the channel 20 before sewage overflows through the aperture 62 is relatively low. The head loss is therefore relatively small and, hence, the sewage flow capacity of the arrangement will be limited. By providing the outer cover member 61 for the overflow aperture 62, an increased level (Level B) of sewage flow can pass through the screen arrangement 28 before the excess flow in the channel 20 passes through the overflow aperture 62, thereby increasing the head loss. As the head loss is increased, the flow capacity of the screen arrangement is also increased. It will be appreciated that, in emergency conditions when the level of flow in the channel 20 is excessively high (Level C), sewage flows over the top of the outer cover member 61.

If an outer cover member 61 is provided, it is also preferable to raise the closure plate or cover 57 for the screen arrangement 28 above the belt screen 30 on the uppermost side of the screen arrangement. For example, as shown in Figure 2, this can be achieved relatively easily by providing a cover 57a (as shown in dashed lines) on the uppermost side of the belt screen 30, the cover extending between the first and second housings 32a, 35a.

In some applications, the need for the overflow aperture 62 may be removed if the channel 20 is already provided with alternative overflow means such as, for

example, an additional overflow weir arranged downstream of the screen arrangement 28.

Referring to Figure 8, there is shown an end view of a part of an outer housing 100 for the screen arrangement 28 to illustrate the sealing arrangement which is provided to substantially prevent any fluid or particles carried by the main sewage flow bypassing the screen panels 38 forming part of the belt screen 30 and flowing to the downstream side of the screen arrangement. A closure member or plate 102 is provided along the longitudinal axis of the screen arrangement 28, the closure plate 102 being arranged between the screen panels 38 and the associated link members 42. Guide members 104 are arranged along the longitudinal axis of the screen arrangement 28, one on each of the upper and lower sides of the link members 42, the guide members 104 preferably being formed from a high density plastic material and being shaped to form a close fit with the inner surface of the outer housing 100 and the closure plate 102.

Each guide member 104 abuts a sealing member 106 which is also formed from a high density plastic material. The guide members 104 serve to guide movement of the link members 42 as the belt screen 30 is driven in a continuous loop, in use. In addition, the guide members 104 provide a seal which serves to prevent the passage of fluids or particles, along a first direction, into the screen arrangement 28 (other than through the screen panels 38). The sealing members 106 provide a seal which serves to prevent the passage of fluids and particles, in an orthogonal direction, into the screen arrangement 28. In addition, a sealing shroud member or cover member 108 is provided along the longitudinal length of the belt screen 30 to provide an additional sealing function. The sealing shroud member 108 extends partially

around the continuous belt screen loop (as illustrated in Figure 2), the sealing shroud member 108 preferably extending at least to the top of the channel 20. It will be appreciated that guide members 104, sealing members 106 and a sealing shroud member 108 are provided on both the front and rear sides of the screen arrangement 28.

The guide member 104 may be integrally formed with the sealing member 106 or may be formed separately.

In practice, the screen arrangement 28 will normally be stationary and will only be activated when a predetermined flow level is reached in the channel 20. When the predetermined flow level is reached, the drive mechanism 32 is activated to drive the belt screen 30 in order to present a continuous moving screening area to the excess flow. The drive mechanism is de-activated when the flow level decreases to below the predetermined flow level.

The drive mechanism 32 for the continuous belt screen 30 is mounted externally to the screen arrangement 28 on the upper wall of the screen arrangement 28, the drive mechanism engaging with both sides of the belt screen 30 to effect the driving connection. Referring to Figure 6, the drive mechanism for one side of the belt screen 30 includes a roller chain 50, formed from a plurality of chain links 52 and driven by means of a chain wheel (not shown) mounted on a drive shaft. The drive shaft is driven by means of a motor (not shown), the roller chain 50 therefore being driven by the chain wheel to effect driving of the belt screen 30. Referring to Figure 7, the roller chain 50 carries bifurcated brackets 58, referred to as "lifting" brackets, by means of a connection with the chain links 52, the brackets 58 being spaced on the roller chain 50 at locations corresponding to the positioning of the link

members 42 of the belt screen 30. As a link member 42 is carried by the roller chain 50 past a bracket 58, a surface of each of the fingers of the bracket 58 comes into contact with a corresponding drive pin 44 on a link member 42. The bracket 58 thereby serves to "lift" the drive pin 44, and hence the link member 42, so as to effect driving of the belt screen 30. A drive mechanism of the aforementioned type is described in our co-pending British Patent Application No. 9909266.0.

Conventionally, screen arrangements of the type including a continuous driven belt screen are arranged in the inlet channel of a sewage treatment plant, the screen arrangement being oriented such that the longitudinal axis is in the vertical direction. Thus, conventional screen arrangements require a relatively large accommodation space in the vertical direction. Additionally, it is common from the continuous belt screens in conventional screen arrangements to be driven by means of a rotating wheel mechanism located within the head space at the uppermost end of the screen arrangement. Conventional screen arrangements of this type are not therefore suitable for use in the present invention as the drive mechanism would inevitably be exposed to excess flow passing through the belt screen. By providing a drive mechanism which is external to the screen arrangement 28, as shown in Figure 2, the screen arrangement 28 can be oriented such that the longitudinal axis is in a substantially horizontal direction along the overflow weir 24. Furthermore, by presenting a relatively large, moving screening area to the excess flow, the present invention also permits a relatively large excess flow to be screened before the level of excess flow exceeds an amount which causes flow to pass through the overflow aperture 62 .

In the embodiment of the invention described hereinbefore, a single screen arrangement 28 is arranged along the overflow weir 24. However, in practice, the overflow weir 24 may be sufficiently long that two or more screen arrangements 28 may be arranged along the weir. By extending the length of the weir, the level of water passing over the weir can be maintained at a relatively low level. As the screen arrangement 28 in the present invention presents a relatively large screening area to the overflow, it can be used with particular advantage in sewerage systems having relatively long overflow weirs.

It will be appreciated that an overflow weir may be provided on either side of the channel and one or more screen arrangements 28 may be arranged along each of the overflow weirs. It will also be appreciated that a single screen arrangement may be used to span a channel providing the channel is sufficiently narrow. In this case, however, it would not be possible to provide an overflow aperture in the front plate.

It will be appreciated that the apparatus or method of the present invention may be employed in any location in a sewerage system in which sewage is being transported through a channel, such as, for example, in a sewage treatment plant or in a sewage channel for delivering sewage flow to a sewage treatment plant.

CLAIMS

1. Apparatus for use in a sewerage system having a channel (20) for a sewage flow (22), the channel (20) having an overflow weir (24) over which an excess flow is discharged when the flow in the channel (20) exceeds a predetermined level, in use, the apparatus comprising a screen arrangement (28) arranged along the overflow weir (24) such that the excess flow passes through the screen arrangement (28) prior to discharge over the overflow weir (24), the screen arrangement (28) comprising a continuous belt screen (30) for capturing screenings contained within the excess flow so as to substantially prevent the discharge of screenings over the overflow weir (24).

2. The apparatus as claimed in Claim 1, wherein the screen arrangement (28) is suspended above the channel (20).

3. The apparatus as claimed in Claim 1 or Claim 2, comprising a drive mechanism (32) located externally to the continuous belt screen (30).

4. The apparatus as claimed in any of Claims 1 to 3, whereby, in use, the direction of travel of the continuous belt screen (30) exposed to the excess flow is substantially along the direction of flow of the sewage flow (22).

5. The apparatus as claimed in any of Claims 1 to 4, wherein the screen arrangement (28) has a longitudinal axis, the longitudinal axis being arranged substantially parallel to the overflow weir (24).

6. The apparatus as claimed in any of Claims 1 to 5, including more than one screen arrangement (28) arranged along the overflow weir (24).

7. The apparatus as claimed in any of Claims 1 to 6, wherein one or more of the screen arrangements (28) comprises means (62) for permitting excess flow exceeding an expected maximum level to by-pass the continuous belt screen (30) and flow directly to an outlet channel so as to substantially prevent flooding of the screen arrangement (28).

8. The apparatus as claimed in Claim 7, wherein one or more of the screen arrangements (28) comprises a front plate (60) provided with an overflow aperture (62).

9. The apparatus as claimed in Claim 8, wherein the or each screen arrangement (28) is provided with an outer cover member (61) for the overflow aperture (62) to permit the sewage flow capacity of the screen arrangement (28) to be increased.

10. The apparatus as claimed in any of Claims 1 to 6, wherein one or more of the screen arrangements (28) spans the channel (20).

11. The apparatus as claimed in any of Claims 1 to 10, wherein the screen arrangement (28) is provided with a sealing arrangement (102, 104, 106, 108) which serves to prevent the passage of flow into the screen arrangement (28) in normal storm conditions, other than the flow screened by the continuous belt screen (30).

12. The apparatus as claimed in Claim 11, wherein the sealing arrangement includes a sealing shroud member (108) which extends partially around the continuous belt screen (30) so as to ensure the sewage flow in the channel (20) is substantially sealed from the downstream side of the screen arrangement (28) in normal storm conditions.

13. The apparatus as claimed in Claim 12, wherein the continuous belt screen (30) has a front facing side and an opposed rear facing side, a sealing shroud member (108) being provided on both the front and rear facing sides.

14. A method of screening an overflow in a sewerage system having a channel (20) provided with an overflow weir (24), comprising the steps of;

arranging a screen arrangement (28) having a continuous belt screen (30) along the overflow weir (24), and

driving the continuous belt screen (30) by means of a drive mechanism (32) so as to present a substantially continuous screening area to the excess flow so as to substantially prevent the discharge of screenings over the overflow weir (24).

15. The method as claimed in Claim 14, comprising the further step of providing means for switching the drive mechanism between on and off states, in response to a measured flow level within the channel (20).

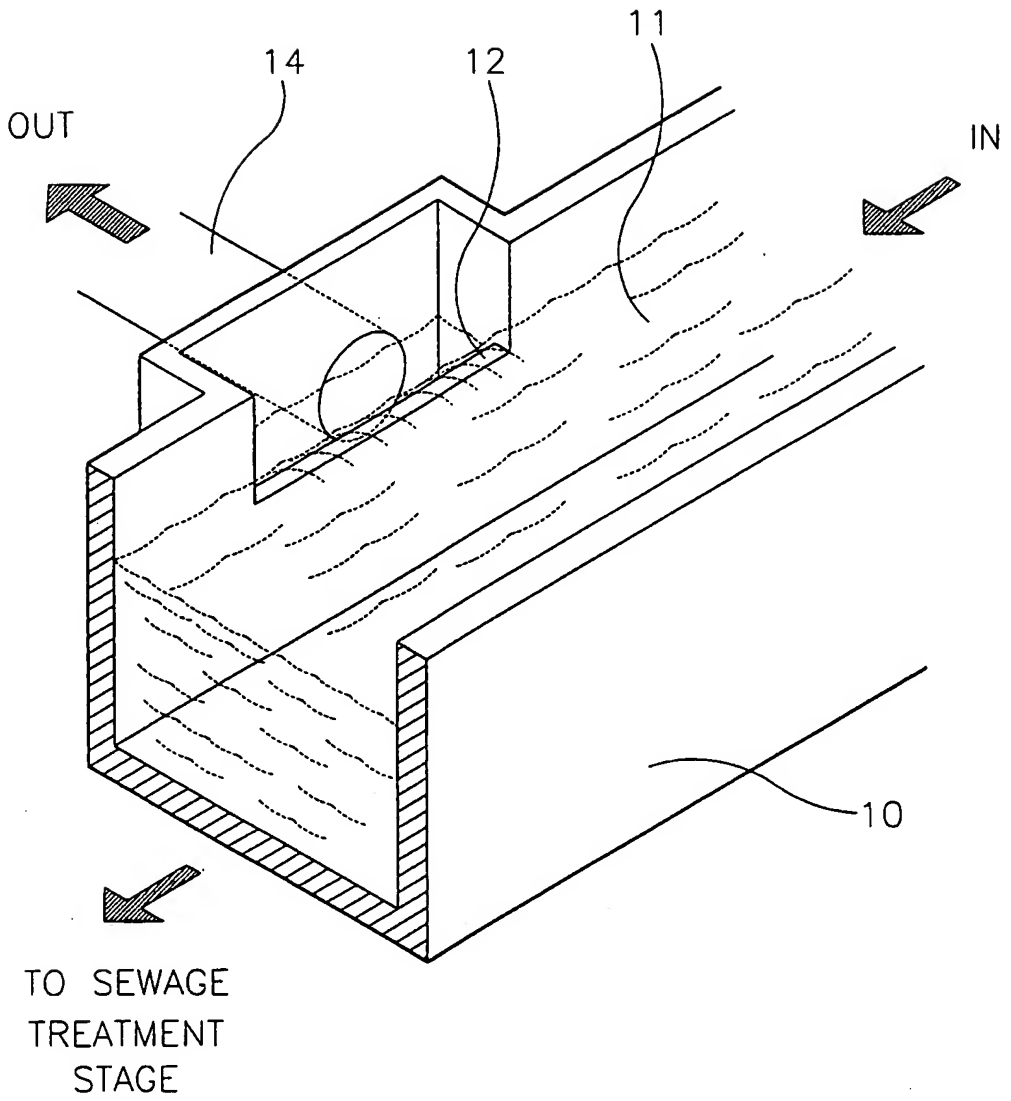


FIG.1
PRIOR ART

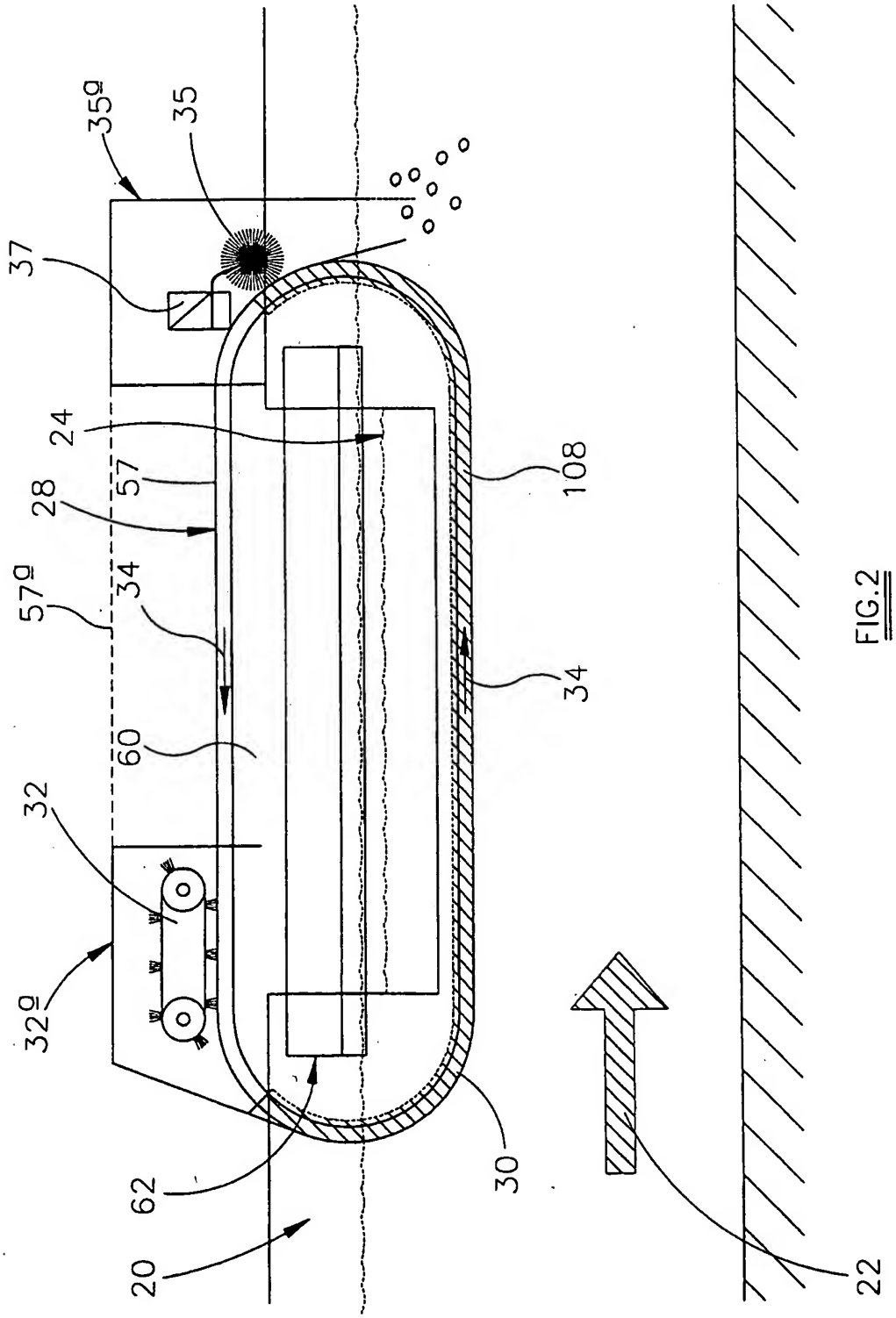


FIG.2

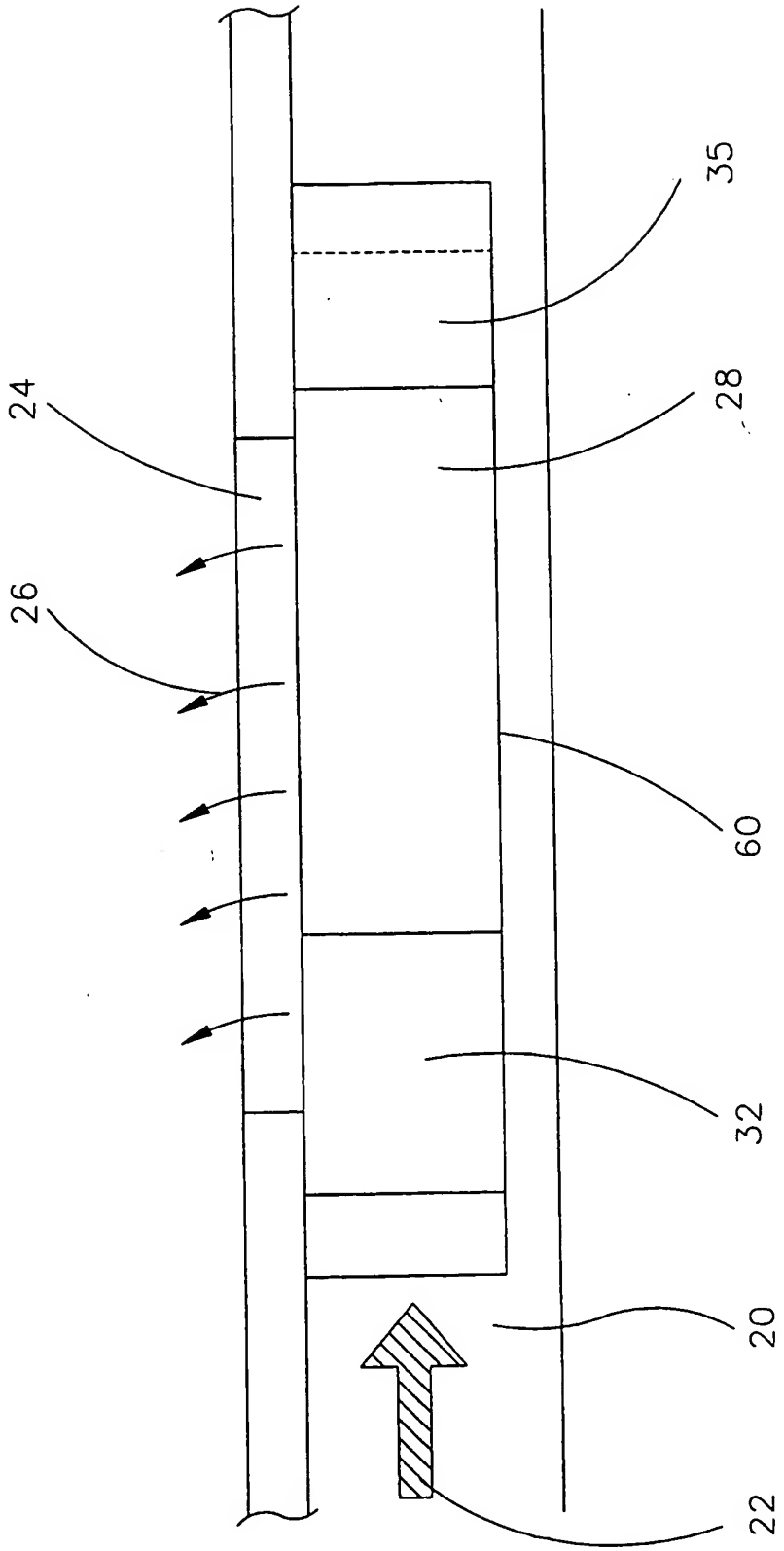


FIG.3

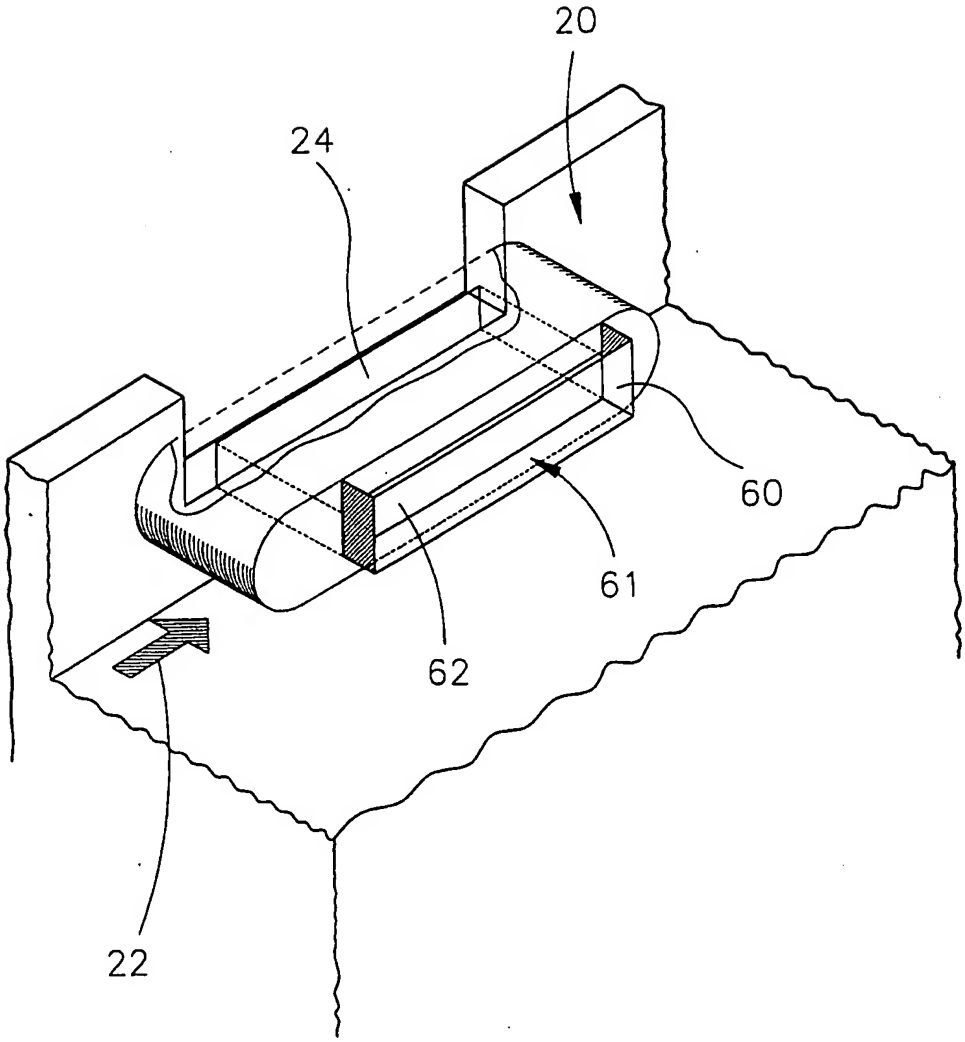


FIG.4

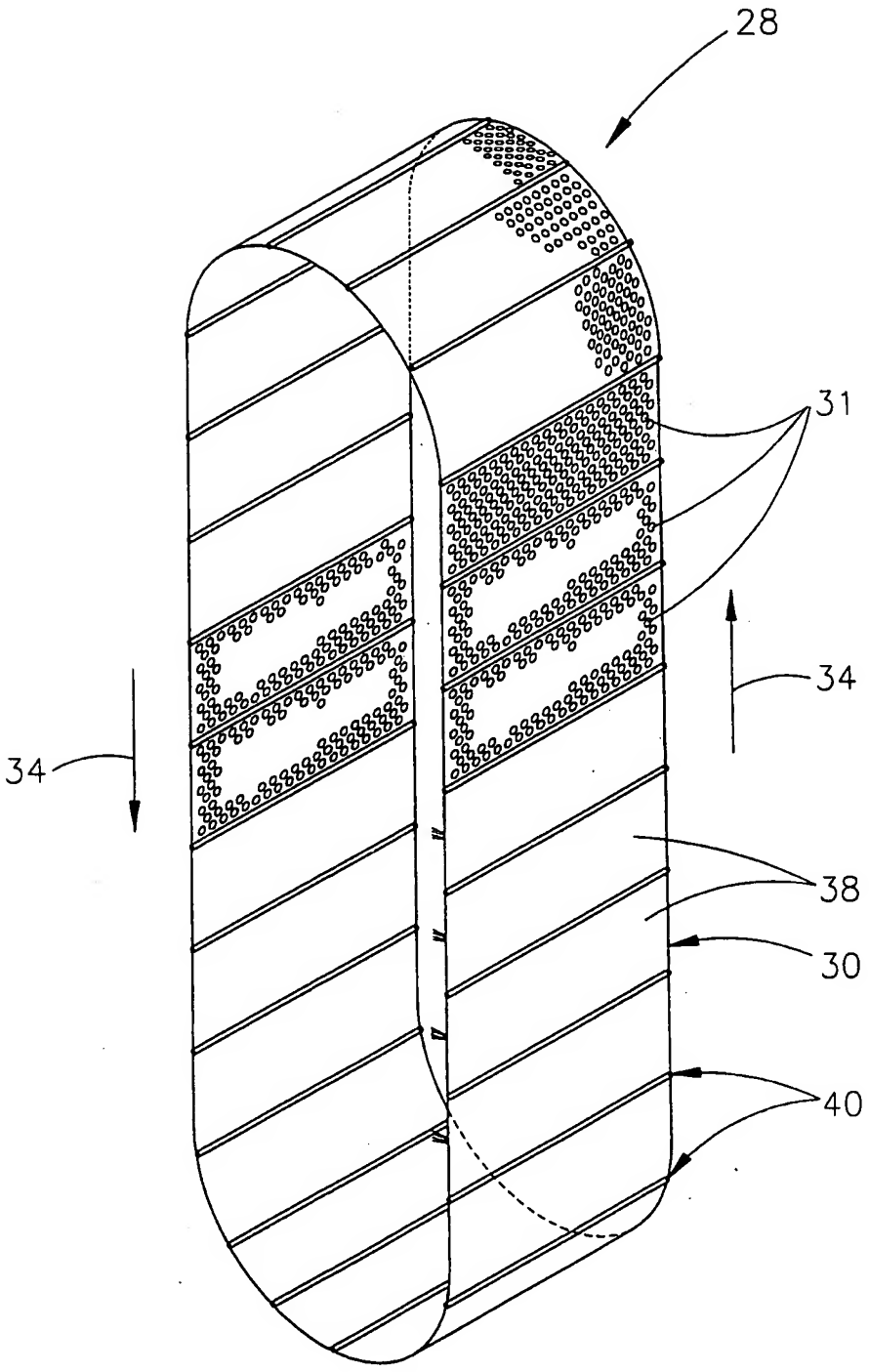


FIG.5

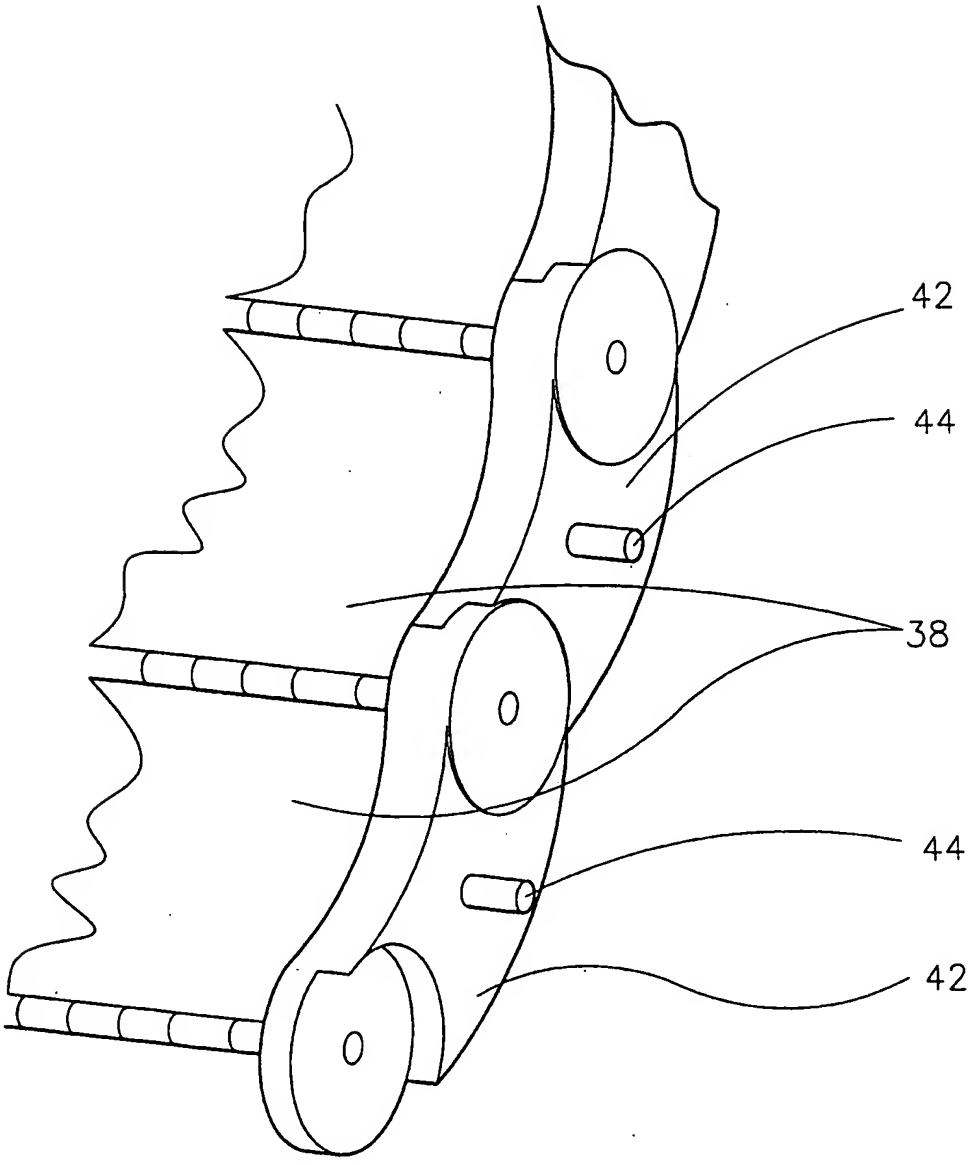


FIG.6

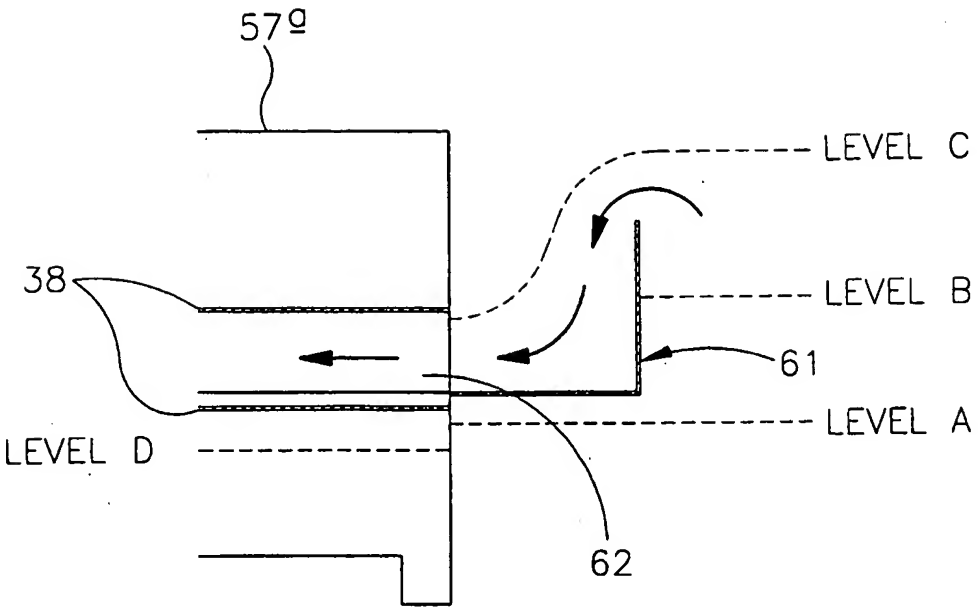


FIG.7

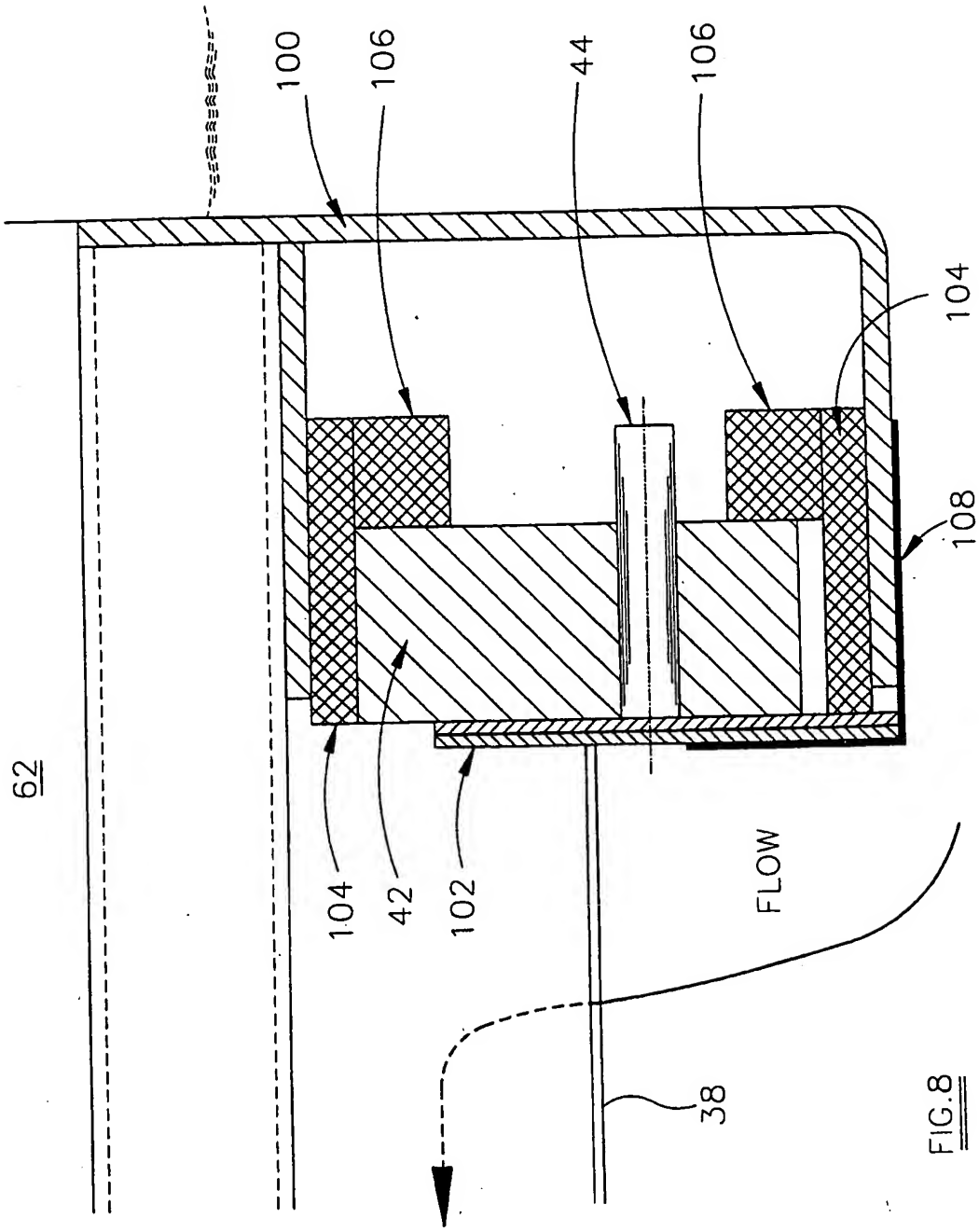


FIG.8

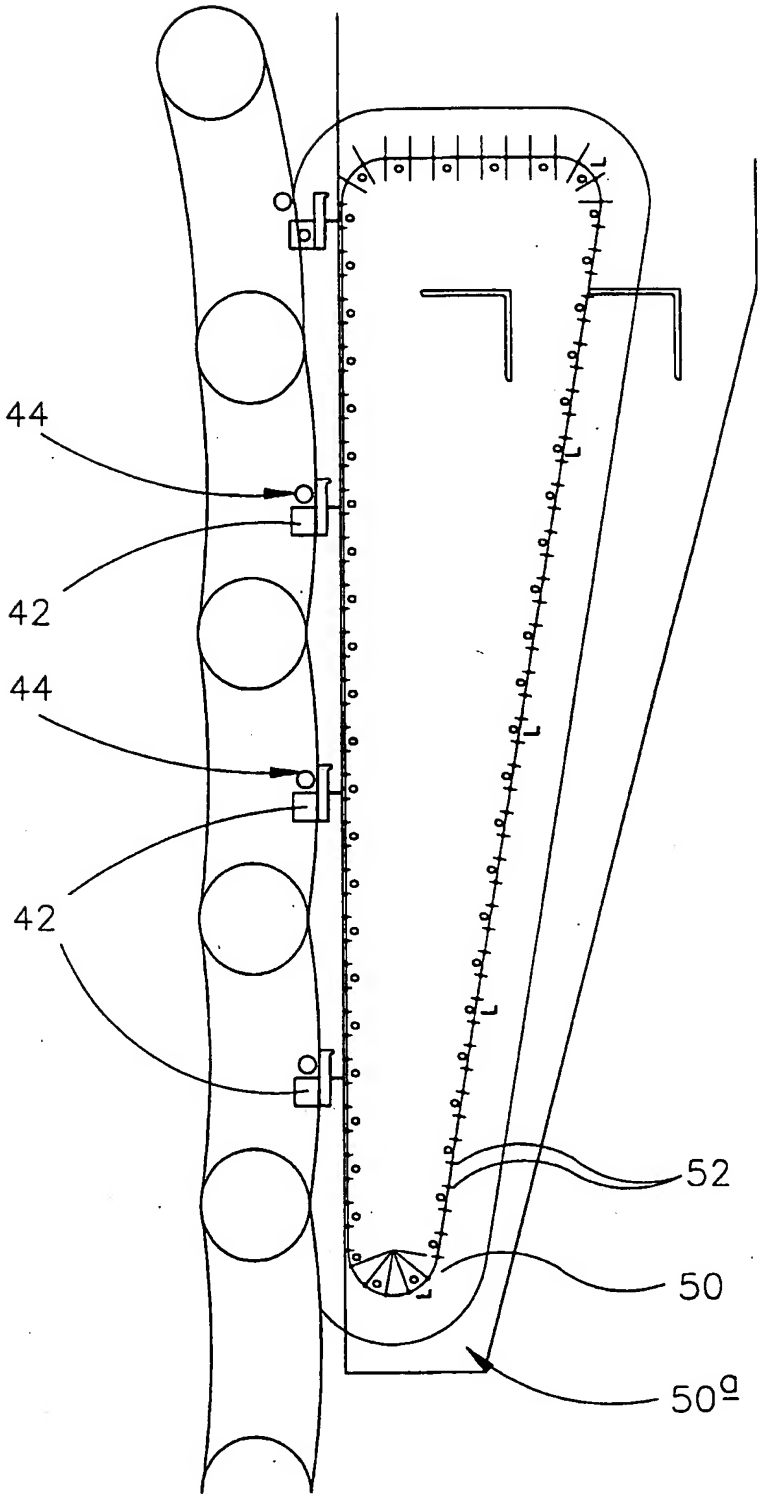


FIG.9

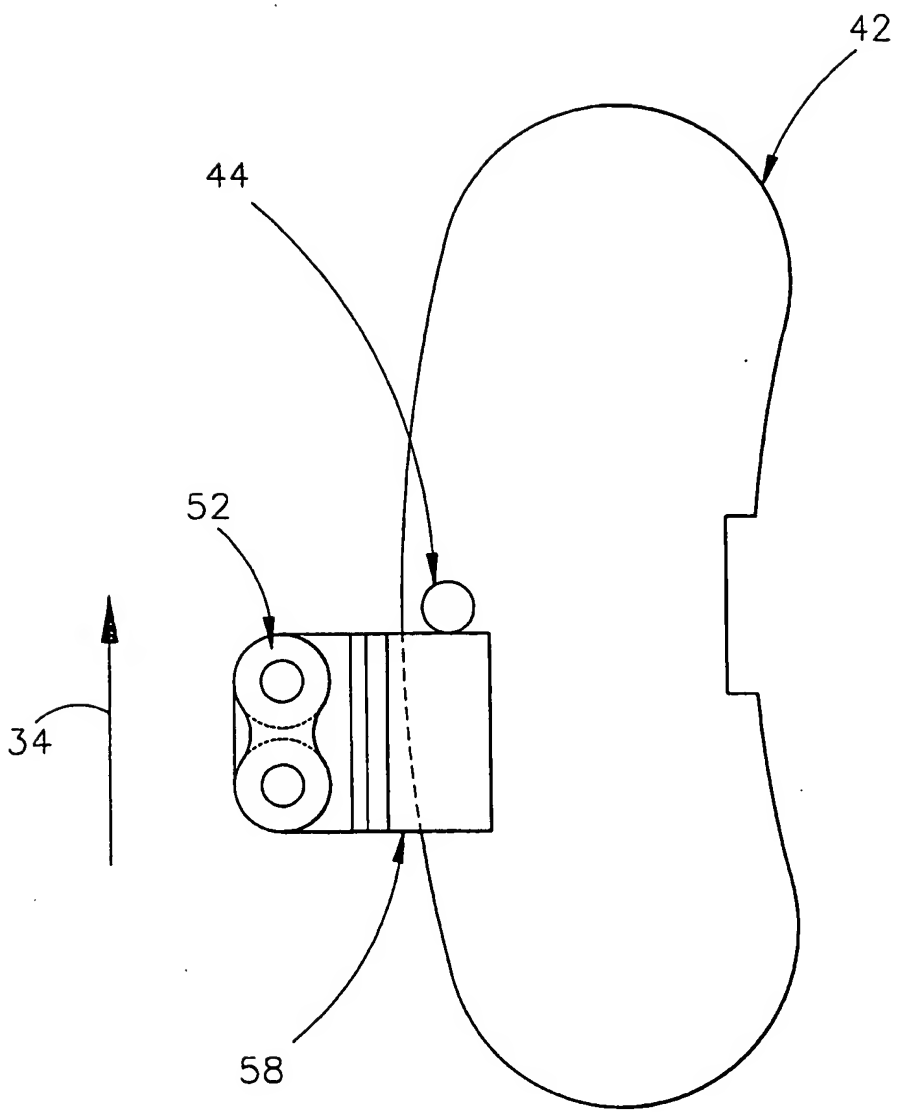


FIG.10

INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/GB 00/04059

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01D33/04 E03F5/14 E02B5/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B01D E03F E02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 41 01 456 A (BROMBACH HANSJOERG) 23 July 1992 (1992-07-23) claims 1-4,21-24; figures 1-3,9	1-3,6, 14,15
E	WO 00 62896 A (BROOKWELL RICHARD ;ROBBINS & MYERS LTD (GB); RAY DAVID (GB); SNOW) 26 October 2000 (2000-10-26) the whole document	1-5,10, 14,15
A	EP 0 636 751 B (GIEHL KLAUS ULRICH) 14 October 1998 (1998-10-14) claims 1-6; figures 1,2,7	1-3,14
A	WO 99 49145 A (CORCORAN PAUL ;TJ BRENT LIMITED (GB)) 30 September 1999 (1999-09-30) claims 1,7; figures 5-8	1,2,5

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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'Y' document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

'&' document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 January 2001	12/01/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Hild, U

2

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PCT/GB 00/04059

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 728 512 A (JONES & ATTWOOD LTD) 28 August 1996 (1996-08-28) the whole document _____	1,14

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INTERNATIONAL SEARCH REPORT

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PCT/GB 00/04059

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		AT 172264 T	15-10-1998
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